SCOFIELD RESERVOIR

Introduction

Scofield Reservoir a 2,815 acre body of water, is located in Carbon County in Central Utah. The reservoir was originally impounded in 1926 and enlarged in 1946. The replacement of the original dam was expedited during World War II because a potential failure of the existing dam posed a threat to the war effort. The project began in 1943 but was not completed until 1946. As part of the authorization for the project was a provision for an 8,000 acre-feet conservation pool . Uses of Scofield Reservoir and its watershed include coal mining, agriculture, residential, fishing, hunting, snowmobiling, camping, and a variety of other types of summer and winter recreations.

Characteristics and Morphometry

Lake elevation (meter / feet)	2,321 / 7,618
Surface area (hectares / acres)	1,139 / 2,815
Watershed area (hectares / acres)	3,990,000 / 4,350,000
Volume (m^3 / acre-feet)	
capacity	90,285,740 / 73,600
conservation pool	9,868,000 / 8,000
Annual inflow (m^3 / acre-feet)	105,716,000 / 52,000
Retention time (years)	1.42
Drawdown (m^3 / acre-feet)	38,073,270 / 30,866
Depth (meters / feet)	
maximum	20.1 / 66
mean	7.9 / 26
Length (km / miles)	7.9 / 4.9
Width (km / miles)	3.3 / 2.1
Shoreline (km / miles)	24.9 / 15.5

Recreation

Scofield Reservoir is accessible from US-6 between Spanish Fork and Price via U-96 or from U-31 between Fairview and Huntington via U-264. The route is well marked on a State highway map and it is accessible year-round. Occasionally during heavy snow conditions travel via U-31 may be restricted. Scofield has traditionally

Location

County	Sanpete
Longitude / Latitude	111 09 10 / 39 46 10
USGS Map	Huntington Reservoir 1978
DeLorme's Atlas and Gazetteer™	Page 46 D-2
Cataloging Unit	San Rafael (14060009)

been one of Utah's top fisheries. Besides producing
desirable size

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and quantities of trout, it is unique in that it is an outstanding shore fishery. It is also popular during the winter as an ice fishery. In recent years the fishery and its management have been impacted due to water quality impairments.

Scofield Reservoir is the site of a State Park. The park provides for camping (both trailers and tents), garbage disposal, water, barbeque pits, flush toilets, hot showers, a fish cleaning station and boat ramps at both camping areas. There are two sites that comprise the park, the Madsen BAy Unit and the Mountain View Unit. In addition a sanitary dump site is available with a convenience store and other support services available in Scofield on the south shore of the reservoir. Facilities are available at the State Park from May through November. Snowmobiling and ice fishing are popular winter sports at Scofield Reservoir too. In addition to all of the public recreation opportunities there is a Boy Scout Camp on the northwest tip of the reservoir.

This area is a very popular recreational site and camping areas are limited. Overflow camping is not allowed in direct proximity to the reservoir, however, there is primative camping available on forest service lands up the Fish Creek drainage.

Limnological Assessment

The water quality of Scofield Reservoir is fair. It is considered to be hard with a hardness concentration value of approximately 187 mg/L ($CaCO_3$). Those parameters that have exceeded State water quality standards for defined beneficial uses are total phosphorus and dissolved oxygen. The average concentrations of total phosphorus in the water column in recent years has usually always exceeded the recommended pollution indicator for phosphorus of 25 ug/L. The problems relating to the excessive enrichment of Scofield Reservoir have been documented in several reports. Historically the data documents summer blue-green algal blooms, winter and summer hypolimnetic oxygen deficits and fish kills as problems associated with the lake.

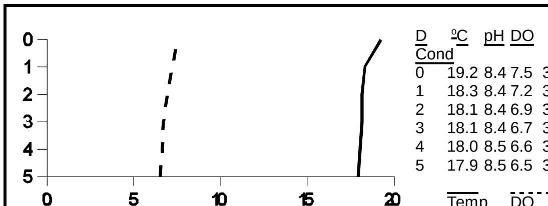
In 1983 a Clean lakes 314 Phase I water quality study was completed on the reservoir. A summary of that study (Scofield Reservoir Phase I Clean Lakes Study, 1983) indicate that the reservoir has good water quality as measured by most parameters. The reservoir was moderately high in alkalinity (155 mg/L) and hardness (170 mg/L). Secchi depth readings for the study period during the summer months range from 2 to 5 meters which

Limnological Data

Data averaged from STORET sites: 593097, 593098, 593099, 593100, 593101, 593107, 593127

Surface Data	1979*	1990	1991	1992
Trophic Status	M	H	H	M
Chlorophyll TSI	-	67.88	65.64	35.62
Secchi Depth TSI	36.10	65.42	65.15	57.82
Phosphorous TSI	53.30	55.41	59.85	53.61
Average TSI	44.70	62.90	63.55	49.02
Chlorophyll a (ug/L)	-	73.7	47.1	2.9
Transparency (m)	2.3	0.6	0.6	2.0
Total Phosphorous (ug/L)	28	33	50	54
pH	9.0	8.4	8.6	8.3
Total Susp. Solids (mg/L)	-	17.2	8	<3
Total Volatile Solids (mg/L)	-	-	6	1
Total Residual Solids (mg/L)	-	-	27	2
Temperature (°C / °f)	15/59	14/57	12/53	17/63
Conductivity (umhos.cm)	218	375	376	328
Water Column Data				
Ammonia (mg/L)	0.10	0.27	0.11	0.2
Nitrate/Nitrite (mg/L)	0.10	-	0.34	0.03
Hardness (mg/L)	-	203	202	156
Alkalinity (mg/L)	-	18	17.3	13
Silica (mg/L)	-	-	6	6.5
Total Phosphorous (ug/L)	28	43	51	60
Miscellaneous Data				
Limiting Nutrient	N	N	N	N
DO (Mg/l) at 75% depth	6.7	4.8	6.7	6.6
Stratification (m)	NO	1-2	NO	NO
Depth at Deepest Site (m)	11	4	5	5

* Data averaged from only 2 sites (593098, 593099)



D	°C	pH	DO	Cond
0	19.2	8.4	7.5	321
1	18.3	8.4	7.2	325
2	18.1	8.4	6.9	326
3	18.1	8.4	6.7	326
4	18.0	8.5	6.6	326
5	17.9	8.5	6.5	326

is typical for mesotropic systems. Nutrient levels are relatively high but drop during the summer as nutrients are depleted by phytoplankton growth. Total phosphorus levels were commonly reported at 10 to 50 ug/L and inorganic nitrogen at 0.10 to 0.30 mg/L.

As expected, dissolved oxygen was low in the hypolimnion. The temperature and dissolved oxygen profiles were similar with other mesotrophic to slightly eutrophic reservoirs in Utah. However it should be noted, anoxic conditions were found near the reservoir bottom during late summer and again during the winter. The report indicated that this only affected a small portion of the water column and for only a short duration.

Scofield Reservoir was determined to be meso-eutrophic in 1981 and 1982 based on overall trophic state indexes (TSI's) of 49.00 and 53.00 respectively. Phytoplankton analyses indicated that the reservoir was meso-eutrophic with the presence of a significant number of blue-green algae species and some diatoms indicative of eutrophic conditions. As part of the study Dr. Samuel R. Rushforth's (1982) algal studies substantiated these trophic state determinations. He concluded that Scofield Reservoir is a meso-eutrophic to eutrophic system dominated by noxious species of blue-green algae (*Anabaena* and *Aphanizomenon*) during the summer and fall months. Although there was a limited diversity during the early part of the year, diatom diversity peaked during the spring with a continued dominance by *Dinobryon divergens* and an increase in green algal production during early summer. By mid August blue-green algal dominance began to evolve and continued into late fall with continued representation of *Dinobryon divergens*. One additional factor in the diatom analysis was the high production of *Stephanodiscus minutula* which is indicative of eutrophic waters when present in the quantities found in the reservoir. It was reported in the Phase I study that the exchangeable phosphorous values in the sediments could become moderate if anoxic conditions were present.

The coverage of macrophytes, almost entirely of *Elodea canadensis*, was extensive throughout all areas of the reservoir in both 1981 and 1982. Although the macrophytes were submergent in most cases, they were present in almost all areas of less than 15 feet of water. During 1982 beds of *Ranunculis aquatilis* and *Polygonum coccineum* occupied the shallow areas at the south end of the reservoir with small areas of *Potamogeton pectinatus* and *Potamogeton filiformis*.

The study suggested four options as the most feasible and beneficial for solving the pollution problems. They were; 1) creation of a south shore wetland to trap nutrients before they can enter the reservoir; 2) increase public awareness and generate support for reduced human impacts; 3) alter the outlet to allow more hypolimnetic discharge; 4) continue to monitor projects through SEUALG (Pleasant Valley Committee).

Data prior to 1992 indicates that the reservoir is a nitrogen limited with consistently high productivity. TSI values in 1990-91 depict the reservoir as hypereutrophic with values in excess of 60.00. These poor water quality conditions were responsible for a decline in the cold water fishery. Christopherson and Judd (1991) linked the overall effect of water quality on the fishery. High algal production, primarily blue-greens, and severe dissolved oxygen depletions were contributing factors to the decline. On April 4, 1990 dissolved oxygen concentrations were documented at a maximum of 4.1 mg/L near the surface, 1.5 mg/L at 2.5 meters and no oxygen below the 5 meter depth. This excessive depletion of dissolved oxygen is indicative of the excessive demand for oxygen in the hypolimnion due to accumulations of organic matter due to the high productivity of the reservoir during recent years. These conditions are critical to the overwintering of fish in the reservoir. DWR reports substantiate the loss of fish during this period of time in the reservoir.

In 1992 an overall TSI value for the reservoir was 49.02 which was significantly lower. It is noteworty that in the fall of 1991 the reservoir was treated for the removal of rough fish. With the treatment it appears that there has been a improvement of conditions. Prior to treatment one factor attributing to the increased eutrophication of the reservoir was the increase in the internal phosphorus loading to the reservoir. One factor contributing to this increase was the resuspension of sediments by non-game fish. With the elimination of those species during treatment a reduction in the internal loading appears to have occurred. In addition the amount of internal phosphorus loading due to anoxic conditions may have been reduced due to greater mixing of the water column due to lower levels of water in recent years. Additional data will be need to ascertain the validity of this phenomenon.

As indicated in the profile of August 8, 1991 the reservoir typically does not stratify during the summer due to insufficient depth.

According to DWR no fish kills have been reported since the last treatment, but prior to treatment fish kills were common. A major contributing factor prior to the treatment in 1991 were anoxic conditions from dissolved oxygen depletions during late summer and winter. Dissolved oxygen concentrations were determined to be well below the threshold established for a viable cold water fishery. This was having a dramatic effect on the fingerling stocked during the fall resulting in very little carryover of these fish. It has also been reported that dry years increased the chances of fish kills.

The reservoir supports populations of rainbow trout

(*Oncorhynchus mykiss*), cutthroat trout (*Oncorhynchus clarki*), an probably some brown trout (*Salmo trutta*) from tributaries.

Phytoplankton in the euphotic zone on August 8, 1991 include the following taxa (in order of dominance)

Species	Cell Volume (mm^3/liter)	% Density By Volume
Aphanizomenon flos-aquae	1 x 10^{17}	100.00
Stephanodiscus niagarae	.175	0.00
Pennate diatoms	.040	0.00
Centric diatoms	.009	0.00
Chlamydomonas globosa	.002	0.00
Total	210.050	

Shannon-Weaver [H']	0.00
Species Evenness	0.00
Species Richness	0.11

Samples from August 18, 1992 include

Species	Cell Volume (mm^3/liter)	% Density By Volume
Sphaerocystis schroeteri	208.639	99.33
Ceratium hirundinella	.936	0.45
Pennate diatoms	.145	0.07
Aphanizomenon flos-aquae	.105	0.05
Asterionella formosa	.095	0.04
Centric diatoms	.062	0.03
Melosira granulata	.056	0.03
Oocystis sp.	.013	0.01
Totals		

Shannon-Weaver Index [H']	0.05
Species Evenness	0.02
Species Richness [d]	0.33

The phytoplankton commnunity was dominated by the presence of blue-green alae and diatoms indicative of poorer water quality and eutrophic conditions in 1991 but in 1992 dominance shifted to green algae and diatoms with some eutrophic species still present in the community.

Pollution Assessment

The Utah Division of Water Quality completed a Phase I - 314 Clean Lake Study at Scofield Reservoir (Denton ed, 1983). This study identified the sources of pollution. Phosphate and nitrate were responsible for the increased eutrophication, with phosphorus identified as the limiting nutrient. For this reason phosphorus was identified as the target parameter for nutrient reduction efforts.

The blue-green algae blooms are linked to high phosphorus concentration in the reservoir. Internal loading of phosphorus involves chemical interactions within the reservoir. With the impoundment of the reservoir in 1946, sediments have been deposited in the reservoir. These sediments contain phosphorus that has been stored in different chemical forms. The phosphorus is bound to other elements (iron and calcium) to form phosphate salts. In summer and winter the lake thermally stratifies so that the hypolimnion (bottom) can not mix with the surface. As the organic material decomposes, free oxygen in the water is utilized causing a reduction in the concentration of dissolved oxygen in the water column. Eventually the hypolimnion becomes anoxic. Under these conditions phosphate salts are changed and bound phosphorus is released into the water (Figure 5). This phosphorus is readily available for biological production. When this phosphorus enters the epilimnion it stimulates algal production. Recently these summer algal blooms are dominated by blue-green algae, which produce large amounts of organic material that sink to the bottom. This deteriorating cycle occurs in Scofield Reservoir. In addition fish species like carp (Cyprinus carpio) may add to the problem of internal loading by resuspending phosphorus laden sediments into the water column, and releasing nutrients into the water.

External loading consists of phosphorus bound to sediments, and dissolved bioavailable phosphorus entering the reservoir from the watershed. The Phase i study reported that approximately 52% of all external loading comes from Fish Creek (3,508 Kg), and Mud Creek (1,943 Kg) annually. The remaining tributaries contribute approximately 18%, and the remaining 5% comes from shoreline erosion.

The external sources of phosphorus include sediment, culinary waste and livestock sewage. Much has been done since 1983 to reduce culinary waste. A more adequate sewage system has been installed in the Scofield area. Erosion and livestock continue to be a problem.

Erosion in the watershed leads directly to sediment release, and the external loading of phosphorus and nitrates into the reservoir. Intensive livestock grazing in the watershed, particularly in riparian zones (stream banks), greatly increases the natural erosion in the area. Combined with road construction, recreational home construction and mining activities the damage to the watershed is considerable.

The Manti La Sal National Forest has completed a Water Resource Inventory for the Price River watershed (G. Dennis Kelly Manti-La Sal National Forest). Computer models (SEDROUT) were used to predict sedimentation. The models were run, and data were compiled on 72,359 acres, in and around the National Forest. Sediment yields were estimated and water shed improvement needs were identified.

Of the land surveyed, 7257 acres or 10.1 percent of the Price watershed was classified as having high to extreme erosion potential. Water quality based on suspended sediments was, estimated to range up to 276 mg/L in Mud Creek.

The effects of the sediment loading and eutrophication can be summarized as follows.

Problems of poor water quality

1. Major algae blooms, leading to loss of the zooplankton an important food for trout.
2. Oxygen depletion which threatens fish populations.
3. Excessive sedimentation into the reservoir.

Effects on Reservoir

1. Visual impacts and offensive odors.
2. Boater and swimmer safety.
3. Low fish survival.
4. Water more costly to treat for Culinary use.
5. Loss of water storage.

Sources of Sedimentation

1. Grazing and resulting loss of vegetation leading to eroding stream banks.
2. Road and vacation home construction.
3. Mining activities.
4. Poor pasture management.
5. Damaged riparian areas.

Effects on the Drainage

1. Threaten cold water fish in streams.
2. Enhance production of non-game fish.
3. Reduce or inhibit trout spawning.
4. Reduced wildlife habitat.
5. Visual impacts.
6. Loss of top soil.
7. Erosion damage to roads.

The following is a list of recommendations that could prove beneficial in the improvement of water quality in this watershed:

1. The Price River/Scofield Reservoir watershed is vital to the area, and the Manti La Sal National Forest should evaluate managing the drainage specifically for water shed protection.
2. Stream bank stabilization and riparian enhancement should continue at an accelerated pace.
3. Wetlands should be created to trap sediments before they enter the reservoir.
4. A project to chemically remove the carp should be undertaken.
5. New fisheries management techniques need to be developed and evaluated. A study should be conducted to evaluate the survival of different sizes of stocked rainbow trout. Other species such as Bear Lake cutthroat trout should be evaluated to determine their survival and potential for natural recruitment.
6. Efforts should continue to inform the public about the importance of our watersheds and how to protect them.
7. Sources of funding must be located. These might include:
   a. Special Agriculture Conservation Program (ACP)
   b. National Forest Service
   c. Wallop-Bureau fisheries enhancement
   d. Water Quality Act, Section 319 (Riparian)
   e. Water Quality Act, Section 314 (Clean Lakes)
   f. Bureau of Reclamation
   g. Flat Water Fisheries Enhancement.
   h. Watershed Protection and Flood Prevention Act (PL- 83-566) USDA SCS
   i. Special Appropriation from Utah State Legislature.

Beneficial Use Assessment

Use designation for the waters of Scofield Reservoir have been established as: (1C) protected for domestic purposes with prior treatment by standard complete treatment processes as required by the Utah Department of Environmental Quality; (2B) protected for boating, water skiing, and similar uses, excluding recreational bathing (swimming), (3A) protected for cold water species of game fish and other cold water aquatic life, including the necessary aquatic organisms in their food chain; and (4) protected for agricultural uses including irrigation of crops and stock watering.

Information

Management Agencies

Manti-La Sal National Forest	637-2817
Six County Commissioners Organization	896-9222
Division of Wildlife Resources	538-4700
Division of Water Quality	538-6146

LAKE REPORTS